R. Whittier Comments on Red Hill Monitoring Well Installation Plan Addendum 02; 25 August 2017

GENERAL COMMENTS

I feel there is too much emphasis on small-scale test when the focus should be on the macro-scale tests (such as a tracer test). The planned small scale tests include:

1. Petrographic analysis of the rock cores to evaluate NAPL retention and mobility;
2. A very limited number of hydraulic infiltration tests (double ring infiltrometer tests) to assess infiltration of precipitation;
3. The equivalent of slug tests in the multi-level monitoring wells to assess hydraulic conductivity; and
4. CO_2 flux monitoring on top of the Red Hill Ridge.

The approach above concentrates on evaluating the amount of fuel that can held within the rock matrix (micro-scale). It is likely that more of the residual fuel in the vadose zone resides in dead end pore space and as a film on the rock (macro-scale). An approach needs to be articulated that can provide defensible numbers for fuel retention both at the micro- and macro-scales. Also, these numbers could change dramatically depending on whether a leak occurs during the dry season (more residual fuel) or wet season (less residual fuel due water being the wetting fluid and also filling the available dead-end pore space).

The upscaling issue is also an issue for the double ring infiltrometer measurements. It will take quite a bit of work to do the double ring infiltrometer tests that will only evaluate less the 1.5 ft^2 of the ridge top. It will be challenging to upscale the very small tested area to evaluate how much rainwater infiltrates through the saprolite cap through present or future contaminated zones, then down to the water table. The proposed tests can certainly produce some impressive numbers, bit will these numbers bear any resemblance to reality and more importantly will the results properly inform the Red Hill investigation process?

The procedure and analytical methods for testing hydraulic conductivity as laid out in Appendix 2 page 17 are essentially slug tests. Slug tests are small scale tests for porous media. Small scale hydraulic conductivity of layered basalts will span several orders of magnitude. It will be challenging to convert the results of these test to a scale that is meaningful for assessing contamination migration. I make this comment understanding that hydraulic conductivity will be one of the parameters evaluated when modeling the aquifer responses to pumping stresses at the Red Hill and Halawa Shafts. However, there are other tests that fall between small scale slug tests and aquifer scale tests that should be considered. First would be an analysis of existing pump test data. Rotzoll et al., (2008) detailed methods for estimating hydraulic conductivity from well capacity tests. The well specific capacity is an attribute in the DLNR well data table making the required data easily available. Also, if the BWS is willing to collaborate, pumping tests could be done using production wells that are within the model domain. This type of test would be particularly valuable if water level observation points could be found near the pumping well. There is such an arrangement at the Moanalua Well field.

I recognize that CO_2 is a product of natural attenuation. However, the prospects for a successful CO_2 flux test are very minimal. The ground surface is separated from the zone of contamination and the water table by hundreds of feet of permeable basalt. Air moves freely through the basalts as observed by Stearns when watching the blasting to excavate a water development tunnel (Steans, 1985) or the observations of the USGS at the fractured rock at Yucca Mountain, Nevada (Thortenson et al., 1989). This air exchange will likely dilute and CO_2 signal below any useful concentration for flux analysis.

There are frequent mentions of focused recharge in the Halawa Quarry and inferences of little to no recharge through the saprolite cap above the USTs seems geared toward establishing a groundwater ridge between the Facility and the Halawa Shaft. It appears a significant amount of resources are directed toward demonstrating that a groundwater high exists between the Red Hill Facility and the Halawa Shaft thus preventing contamination migration to the Halawa Shaft. This logic can certainly be pursued, but for it to be accepted it must be shown by a preponderance of the evidence such a groundwater ridge exists. Before expending too many resources on this effort some good desk top analysis could be informative as to whether or not this logic is valid.

It is not that these tests have no value, but rather, is the value of data acquired justified by the cost required to do the test unless the upscaling issues can be resolved? Perhaps a more beneficial expenditure of resources would be a timely and comprehensive analysis of the existing data. We are approaching 4 years since the release and 2 years since the first AOC scoping meeting, and a good analysis of the rich data set that already exists falls far short of what should have been done given the significant elapsed time. The design of the remainder of the Red Hill investigation could benefit immensely from a comprehensive analysis of existing data.

SPECIFIC COMMENTS

Page 2-1; Lines 31-37 and Page 2-3; Table 2-1

The two issues with the current RHMW01 are the small diameter that results in very slow sample pump flow rates requiring extended sampling time to collect enough sample volume, and the inability to monitor of LNAPL on the water table. The first issue will be resolved, but it is unclear how the presence of LNAPL will be evaluated if the WestBay system is installed. This needs to be made clear since this well is located within the footprint of the USTs and monitoring for LNAPL on frequent basis is an important part of the groundwater protection procedures. If the intention is to test for LNAPL based on groundwater sampling results, will this well be sampled monthly at the same time the oil/water interface monitoring is done?

Page2-3; Table 2-1, RHMW07D

Perhaps some more thought needs to be put into RHMW07D. What are the possible causes of the water table elevation anomaly and where will replacement well be located to ensure that the groundwater encountered in the new well does not suffer from the same problems as the existing well? Perhaps the specific well location could be revisited after installation and testing of RHMW11.

Page 2-4: Table 2-1, RHMW13

This well (RHMW13) should be a priority well since it can help define the extent upslope where the alluvium/valley fill are no longer affording protection to the Halawa Shaft.

Page 2-4: Table 2-1, RHMW16

One of the purposes of this and other wells is to investigate whether or not there is a groundwater mound between the Red Hill Facility and the Halawa Shaft. It seems some preliminarily and quantitative hydrologic assessment could be done to see if the groundwater mound hypothesis is reasonable. A good first step would be to compare the water levels in the HDMW and the piezometer installed along side of the HDMW. Data collected in 2006 indicated the WL in the piezometer was about 2 ft lower than in the HDMW. If this is true, the hypothesis of the groundwater mound (or ridge) becomes very weak.

Page 2-5: Table 2-1, RHMW18

Some of these wells seem redundant with monitoring wells the BWS is installing. To more effectively utilize public money a higher level of collaboration, similar to what was suggested by BWS in respect to RHMW09, could significantly reduce the cost of this investigation. This comment applies to the Navy and BWS equally.

Page 2-9; Table 2-2

Some of the surface elevations seem to be in error. For example the elevation at RHMW16 is likely closer to 500 ft msl. Estimated depth to bedrock for all wells except RHMW17 and RHMW18 appear to be above the water table negating some of the rationale for the boreholes.

Page 2-10; First Bullet

The proposed benchmark LNAPL thickness of 0.25 inches seems awful thick. The borehole is being drilled in layered/fractured basalt not porous medium where these is little surface tension to support a thick LNAPL layer. A thickness of 0.05 inches would be more appropriate.

Page 2-10; Section 2.3 Installation of RHMW01R

The Navy should consider evaluating vadose zone for past occurrences of perched water (i.e. zones of weather rock or rock with mineral deposits on the surface). Isolating such a zone with packers and installation of a sampling port may prove useful in evaluating movement of water and contamination in the vadose zone during periods of heavy rain or should a release occur. Past cores from the tunnel wells have shown evidence consistent with transitory perched water as have some of the soil vapor monitoring probes.

Page 2-13; Lines 10-15

As described in the general comments, concentrating on LNAPL trapped in cores or LNAPL mobility with the rock matrix does not seem to capture the major LNAPL conduits. The major transport conduits will be the fractures (hard to characterize in vertical cores) and the interflow boundaries. The approach appears to focus on the micropore structures that are very poor conduits for contaminant migration.

Page 3-4; Lines 3-12

As stated in previous reviews of the MWIWP, perched water will almost certainly be encountered in some of the boreholes. This includes RHMW11, RHMW07D, RHMW12, RHMW13 due to their proximity to the stream or placement near where other investigations have found perched water. Thus it is critical that the tests for perched water be frequent since perched water zones could be drilled through pretty quickly. See other comments below on this subject. More comprehensives checks for perched water are stated in Appendix C; Page C-7; Lines 2-8 and should also appear here.

Page 3-5; Lines 41-42

The decision criteria listed in Section 3.3.1, page 3-4, Lines 38-39 for abandoning boreholes should be restated here.

Page 3-10; Lines 29-35

Hydraulic tests of small bore wells in very permeable basalt may not yield much usable data. See comment below.

Appendix A; Page 17

This is essentially a slug test. Two issues, 1) the bulk hydraulic conductivity is so high that slug tests are of little value; 2) within discrete intervals the hydraulic conductivity values can span orders of magnitude; 3) It will take many reliable tests and proper upscaling to produce any meaningful data.

Appendix C; Page C-7; Lines 2-8

This is much more detailed than the perched water checks procedures in the main body of the MWIWP Addn2. Perched water is most likely in other wells and this procedure should be the standard.

REFERENCES

Rotzoll, K., and A.I. El-Kadi. 2008. Estimated hydraulic conductivity from specific capacity for Hawaii Aquifers, USA. Hydrogeology Journal. 16(5). 696-979

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Stearns, H.T. 1985. Geology of the State of Hawaii, 2nd Edition. Pacific Books Publishers, Palto Alto, Ca. Page 297